NUCLEAR ENERGY RESEARCH INITIATIVE

Accelerator-Based Study of Irradiation Creep of Pyrolytic Carbon Used in TRISO Fuel Particles for the VHTR

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Collaborators: Oak Ridge National Laboratory; Idaho National Laboratory

Project Number: 06-113

Program Area: Advanced Fuel Cycle Initiative

Project Description

Pyrolytic carbon (PyC) is one of the structural materials in the TRISO fuel particles which will be used in the next generation of gas-cooled very-high-temperature reactors. When the TRISO particles are under irradiation, creep of the pyrocarbon layers can cause radial cracking leading to catastrophic particle failure. Therefore, a fundamental understanding of the creep behavior of PyC during irradiation is required to predict the overall fuel performance.

The primary objective of this project is to characterize the creep behavior of PyC through a systematic program of accelerator-based proton irradiation and *in-situ* measurements under stress at various temperatures between 400°C and 1,200°C. Test data will be analyzed to determine creep coefficients, which will then be correlated to existing coefficients measured under neutron irradiation. In addition, initial experiments on the transport of select fission products (e.g., Ag and Sr) in PyC under irradiation and stress will be conducted by implanting ions into the sample surface. The PyC microstructure will be studied with advanced analytical transmission electron microscopy (TEM).

Workscope

The project will perform the following activities:

- Modify the ion accelerator target chamber and test overall system design and operation (temperature control and creep measurement during proton irradiation).
- Characterize PyC samples
- Conduct low-temperature irradiation (400°C and 600°C) on the reference microstructure (unloaded) and perform data analyses
- Conduct low-temperature irradiation on the microstructure under stress and perform data analyses
- Conduct high-temperature irradiation (800°C, 1,000°C, and 1,200°C) and perform data analyses
- Perform irradiation of samples with pre-implanted fission product and cross-sectional TEM analyses
- Conduct final data analyses and empirical modeling